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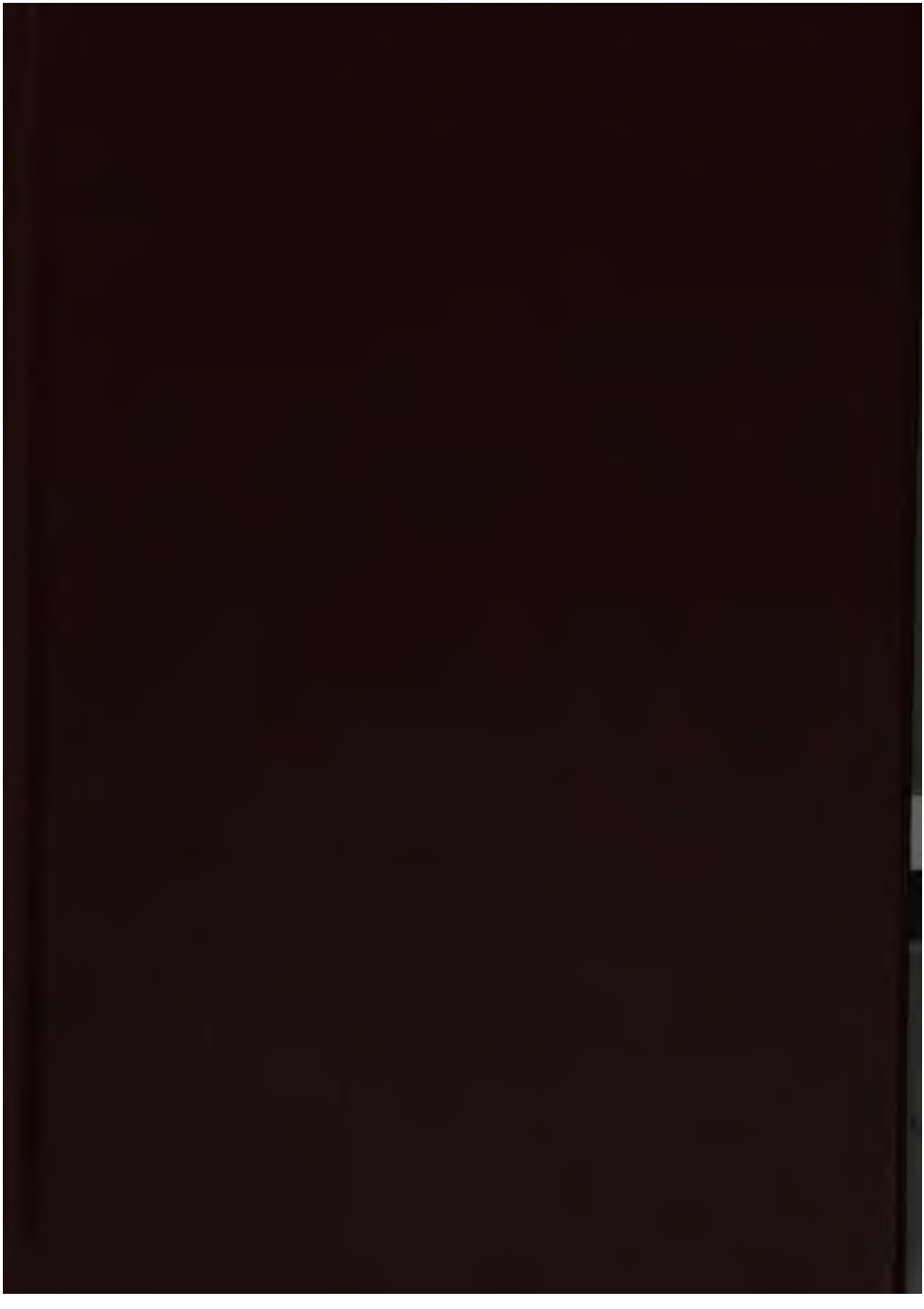

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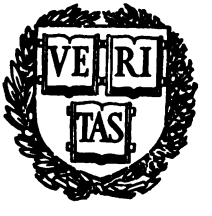

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HARLES DARWIN.

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"Art and eloquence,
And all the shows o' the world are frail and vain
To weep a loss that turns their light to shade.
It is a woe 'too deep for tears,' when all
Is reft at once, when some surpassing Spirit,
Whose light adorned the world around it, leaves
Those who remain behind nor sobs nor groans,
The passionate tumult of a clinging hope;
But pale Despair and cold Tranquillity,
Nature's vast frame, the web of human things,
Birth and the grave, that are not as they were."

SHELLEY.

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Charles Darwin

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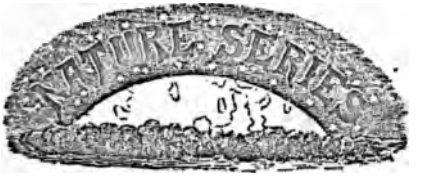

CHARLES DARWIN.

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INTRODUCTORY NOTICE.

VERY few, even among those who have taken the keenest interest in the progress of the revolution in natural knowledge set afoot by the publication of the *Origin of Species*, and who have watched, not without astonishment, the rapid and complete change which has been effected both inside and outside the boundaries of the scientific world in the attitude of men's minds towards the doctrines which are expounded in that great work, can have been prepared for the extraordinary manifestation of affectionate regard for the man, and of profound reverence for the philosopher, which followed the announcement of the death of Mr. Darwin.

Not only in these islands, where so many have felt the fascination of personal contact with an

intellect which had no superior, and with a character which was even nobler than the intellect; but, in all parts of the civilised world, it would seem that those whose business it is to feel the pulse of nations and to know what interests the masses of mankind, were well aware that thousands of their readers would think the world the poorer for Darwin's death, and would dwell with eager interest upon every incident of his history. In France, in Germany, in Austro-Hungary, in Italy, in the United States, writers of all shades of opinion, for once unanimous, have paid a willing tribute to the worth of our great countryman, ignored in life by the official representatives of the kingdom, but laid in death among his peers in Westminster Abbey by the will of the intelligence of the nation.

It is not for us to allude to the sacred sorrows of the bereaved home at Down; but it is no secret that, outside that domestic group, there are many to whom Mr. Darwin's death is a wholly irreparable loss. And this not merely because of his wonderfully genial, simple, and generous nature; his cheerful and animated conversation, and the infinite variety and accuracy of his information; but

because the more one knew of him, the more he seemed the incorporated ideal of a man of science. Acute as were his reasoning powers, vast as was his knowledge, marvellous as was his tenacious industry, under physical difficulties which would have converted nine men out of ten into aimless invalids; it was not these qualities, great as they were, which impressed those who were admitted to his intimacy with involuntary veneration, but a certain intense and almost passionate honesty by which all his thoughts and actions were irradiated, as by a central fire.

It was this rarest and greatest of endowments which kept his vivid imagination and great speculative powers within due bounds; which compelled him to undertake the prodigious labours of original investigation and of reading, upon which his published works are based; which made him accept criticisms and suggestions from any body and every body, not only without impatience, but with expressions of gratitude sometimes almost comically in excess of their value; which led him to allow neither himself nor others to be deceived by phrases, and to spare neither time nor pains in order to

obtain clear and distinct ideas upon every topic with which he occupied himself.

One could not converse with Darwin without being reminded of Socrates. There was the same desire to find some one wiser than himself; the same belief in the sovereignty of reason; the same ready humour; the same sympathetic interest in all the ways and works of men. But instead of turning away from the problems of nature as hopelessly insoluble, our modern Philosopher devoted his whole life to attacking them in the spirit of Heraclitus and of Democritus, with results which are as the substance of which their speculations were anticipatory shadows.

The due appreciation or even enumeration of these results is neither practicable nor desirable at this moment. There is a time for all things—a time for glorying in our ever-extending conquests over the realm of nature, and a time for mourning over the heroes who have led us to victory.

None have fought better, and none have been more fortunate, than Charles Darwin. He found a great truth trodden under foot, reviled by bigots, and ridiculed by all the world; he lived long enough

to see it, chiefly by his own efforts, irrefragably established in science, inseparably incorporated with the common thoughts of men, and only hated and feared by those who would revile, but dare not. What shall a man desire more than this? Once more the image of Socrates rises unbidden, and the noble peroration of the *Apology* rings in our ears as if it were Charles Darwin's farewell:—

"The hour of departure has arrived, and we go our ways—I to die and you to live. Which is the better, God only knows."

T H. H.

CHARLES DARWIN.

CHARLES DARWIN.

I.

CHARACTER AND LIFE.

THE object of this notice is to give a brief account of the life, and a proportionately still more brief account of the work of Mr. Darwin. But while we recognise in him perhaps the greatest genius and the most fertile thinker, certainly the most important generaliser and one of the few most successful observers in the whole history of biological science, we feel that no less great, or even greater than the wonderful intellect was the character of the man. Therefore it is in his case particularly and pre-eminently true that the first duty of biographers will be to render some idea, not of what he did, but of what he was. And this, unfortunately, is just the

point where all his biographers must necessarily fail. For while to those favoured few who were on terms of intimate friendship with him, any language by which it is sought to portray his character must seem inadequate, to every one else the same language must appear the result of enthusiastic admiration, finding vent in extravagant panegyric. Whatever is great and whatever is beautiful in human nature found in him so luxuriant a development, that no place or chance was left for any other growth, and in the result we beheld a magnificence which, unless actually realised, we should scarcely have been able to imagine. Any attempt, therefore, to describe such a character must be much like an attempt to describe a splendid piece of natural scenery or a marvellous work of art; the thing must itself have been seen, if any description of it is to be understood.

But without attempting to describe Mr. Darwin's character, if we were asked to indicate the features which stood out with most marked prominence, we should first mention those which, from being conspicuous in his writings, are already more or less known to all the world. Thus, the absorbing desire to seek out truth for truth's sake, combined with a

characteristic disregard of self, led not only to the caution, patience, and candour of his own work—which are proverbial—and to the generous satisfaction which he felt on finding any of his thoughts or results independently attained by the work of others; but also to a keen and vivid freshness of interest in every detail of a new research, such as we have sometimes seen approached by much younger men when the research happens to have been their own. And indeed what we may call this fervid youthfulness of feeling extended through all Mr. Darwin's mind, giving, in combination with his immense knowledge and massive sagacity, an indescribable charm to his manner and conversation. Animated and fond of humour, his wit was of a singularly fascinating kind, not only because it was always brilliant and amusing, but still more because it was always hearty and good-natured. Indeed, he was so exquisitely refined in his own feelings, and so almost painfully sensitive to any display of questionable taste in others, that he could not help showing in his humour, as in the warp and woof of his whole nature, that in him the man of science and the philosopher were subordinate to the gentleman. His courteous consideration of others,

also, which went far beyond anything that the ordinary usages of society require, was similarly prompted by his mere spontaneous instinct of benevolence.

> For who can always act? but he
> To whom a thousand memories call;
> Not being less but more than all
> The gentleness he seemed to be,
>
> Best seem'd the thing he was, and join'd
> Each office of the social hour
> To noble manners, as the flower
> And native growth of noble mind;
>
> Nor ever narrowness or spite,
> Or villain fancy sweeping by,
> Drew in the expression of an eye,
> Where God and Nature met in light.

And this leads us to speak of his kindness, which, whether we look to its depth or to its width, must certainly be regarded as perhaps the most remarkable feature of his remarkable disposition. The genuine delight that he took in helping every one in their work—often at the cost of much personal trouble to himself—in throwing out numberless suggestions for others to profit by, and in kindling the enthusiasm of the humblest tyro in science; this was the outcome of a great and generous heart, quite as much as it was due to a desire for the advance-

ment of science. Nothing seemed to give him a keener joy than being able to write to any of his friends a warm and glowing congratulation upon their gaining some success; and the exuberance of his feelings on such occasions generally led him to conceive a much higher estimate of the importance of the results attained than he would have held had the success been achieved by himself. For the modesty with which he regarded his own work was no less remarkable than his readiness enthusiastically to admire the work of others; so that, to any one who did not know him well, this extreme modesty, from its very completeness and unconsciousness, might almost have appeared the result of affectation. At least, speaking for ourselves, when we first met him, and happened to see him conversing with a greatly younger man, quite unknown either in science or literature, we thought it must have been impossible that Mr. Darwin—then the law-giver to the world of biology—could with honest sincerity be submitting, in the way he did, his matured thought to the judgment of such a youth. But afterwards we came fully to learn that no one was so unconscious of Mr. Darwin's worth as Mr. Darwin himself, and

that it was a fixed habit of his mind to seek for opinions as well as facts from every available quarter. It must be added, however, that his tendency to go beyond the Scriptural injunction in the matter of self-approval, and to think of *others* more highly than he ought to think, never clouded his final judgment upon the value of their opinions; but, spontaneously following another of these injunctions, while proving all things, he held fast only to that which was good. "In malice be ye children, but in understanding be ye men."

On the whole, then, we should say that Mr. Darwin's character was chiefly marked by a certain grand and cheerful simplicity, strangely and beautifully united with a deep and thoughtful wisdom, which, together with his illimitable kindness to others and complete forgetfulness of himself, made a combination as lovable as it was venerable. It is, therefore, not to be wondered at that no man ever passed away leaving behind him a greater void of enmity, or a depth of adoring friendship more profound.

But, as we have said, it is impossible to convey in words any adequate conception of a character

which in beauty as in grandeur can only, with all sobriety, be called sublime. If the generations are ever to learn, with any approach to accuracy, what Mr. Darwin was, his biographers may best teach them by allowing this most extraordinary man to speak for himself through the medium of his correspondence, as well as through that of his books; and therefore, as a small foretaste of the complete biography which will some day appear, we shall quote a letter in which he describes the character of his great friend and teacher, the late Prof. Henslow, of Cambridge. We choose this letter to quote from on account of the singular manner in which the writer, while describing the character of another, is unconsciously giving a most accurate description of his own. It is of importance also that in any biographical history of Mr. Darwin, Prof. Henslow's character should be duly considered, seeing that he exerted so great an influence upon the expanding powers of Mr. Darwin's mind. We quote the letter from the Rev. L. Jenyns' *Memoir of the late Prof. Henslow.*

"I went to Cambridge early in the year 1828, and soon became acquainted, through some of my

brother entomologists, with Prof. Henslow, for all who cared for any branch of natural history were equally encouraged by him. Nothing could be more simple, cordial, and unpretending than the encouragement which he afforded to all young naturalists. I soon became intimate with him, for he had a remarkable power of making the young feel completely at ease with him, though we were all awe-struck with the amount of his knowledge. Before I saw him, I heard one young man sum up his attainments by simply saying that he knew everything. When I reflect how immediately we felt at perfect ease with a man older, and in every way so immensely our superior, I think it was as much owing to the transparent sincerity of his character as to his kindness of heart, and perhaps even still more to a highly remarkable absence in him of all self-consciousness. We perceived at once that he never thought of his own varied knowledge or clear intellect, but solely on the subject in hand. Another charm, which must have struck every one, was that his manner to a distinguished person and to the youngest student was exactly the same: to all, the same winning

courtesy. He would receive with interest the most trifling observation in any branch of natural history, and however absurd a blunder one might make, he pointed it out so clearly and kindly that one left him in no way disheartened, but only determined to be more accurate the next time. So that no man could be better formed to win the entire confidence of the young and to encourage them in their pursuits. . . . .

"During the years when I associated so much with Prof. Henslow, I never once saw his temper even ruffled. He never took an ill-natured view of any one's character, though very far from blind to the foibles of others. It always struck me that his mind could not be well touched by any paltry feeling of envy, vanity, or jealousy. With all this equability of temper, and remarkable benevolence, there was no insipidity of character. A man must have been blind not to have perceived that beneath this placid exterior there was a vigorous and determined will. When principle came into play, no power on earth could have turned him an hair's breadth. . . . .

"In intellect, as far as I could judge, accurate

powers of observation, sound sense, and cautious judgment seemed predominant. Nothing seemed to give him so much enjoyment as drawing conclusions from minute observations. But his admirable memoir on the geology of Anglesea shows his capacity for extended observations and broad views. Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest characters, in pre-eminence, over his intellect."

Charles Robert Darwin was born at Shrewsbury on February 12, 1809. His father was Dr. R. W. Darwin, F.R.S., a physician of eminence, who, as his son used frequently to remark, had a wonderful power of diagnosing diseases, both bodily and mental, by the aid of the fewest possible number of questions; and his quickness of perception was such that he could even divine, in a remarkable manner, what was passing through his patients' minds. That, like his son, he was benevolently inclined, may be inferred from a little anecdote which we once heard Mr. Darwin tell of him while speaking of the curious kinds of pride which are sometimes shown by the poor. For the benefit

of the district in which he lived Dr. Darwin offered to dispense medicines *gratis* to any one who applied and was not able to pay. He was surprised to find that very few of the sick poor availed themselves of his offer, and guessing that the reason must have been a dislike to becoming the recipients of charity, he devised a plan to neutralise this feeling. Whenever any poor persons applied for medical aid, he told them that he would supply the medicine, but that they must pay for the bottles. This little distinction made all the difference, and ever afterwards the poor used to flock to the doctor's house for relief as a matter of right.

Mr. Darwin's mother was a daughter of Josiah Wedgwood. Little is at present known concerning his early life, and it is questionable whether we can hope to learn much with reference to his boyhood or youth, till the time when he entered at Edinburgh. We can, therefore, only say that he went to Shrewsbury School, the head master of which was at that time Dr. Butler, afterwards Bishop of Lichfield. He was sent to Edinburgh (1825) because it was intended that he should follow his father's profession,

and Edinburgh was then the best medical school in the kingdom. He studied under Prof. Jameson, but does not seem to have profited at all by whatever instruction he received; for not only did it fail to awaken in him any special love of natural history, but even seems to have had the contrary effect.

The prospect of being a medical practitioner proving distasteful to him, he was, after two sessions at Edinburgh, removed to Christ's College, Cambridge, with the view of his entering the Church. He took his B.A. in 1831, and his M.A. in 1837. There being no Natural Sciences Tripos at that time, his degree was an ordinary one. While at Cambridge he attracted the notice of the late Rev. Prof. Henslow, who had just previously exchanged the Professorship of Mineralogy for that of Botany. From the above description of this man's character and attainments, it is sufficiently evident that he was a worthy teacher of a worthy pupil; and the world owes an immense debt of gratitude to him for having been the means of enthusiastically arousing and sagaciously directing the first love and the early study of natural science in the mind

of Darwin. No one can be more deeply moved by a sense of this gratitude than was Mr. Darwin himself. His letters, written to Prof. Henslow during his voyage round the world, overflow with feelings of affection, veneration, and obligation to his accomplished master and dearest friend—feelings which throughout his life he retained with undiminished intensity. As he used himself to say, before he knew Prof. Henslow, the only objects of natural history for which he cared were foxes and partridges. But owing to the impulse which he derived from the field excursions of the Henslow class, he became while at Cambridge an ardent collector, especially in the region of entomology; and we remember having heard him observe that the first time he ever saw his own name in print was in connection with the capture of an insect in the fens.

During one of these excursions Prof. Henslow told him that he had been commissioned (through Prof. Peacock) to offer any competent young naturalist the opportunity of accompanying Captain Fitzroy as a guest on the surveying voyage of the *Beagle*, and that he would strongly urge its acceptance

on him. Mr. Darwin had already formed a desire to travel, having been stimulated thereto by reading Humboldt's *Personal Narrative;* so after a short hesitation on the part of his father, who feared that the voyage might "unsettle" him for the Church, the matter was soon decided, and in December of 1838 the expedition started. During the voyage he suffered greatly from sea-sickness, which, together with the fasting and fatigue incidental to long excursions over-land, was probably instrumental in producing the dyspepsia to which, during the remainder of his life, he was a victim. Three years after returning from this voyage of circumnavigation, he married, and in 1842 settled at Down, in Kent. The work which afterwards emanated from that quiet and happy English home, which continued up to the day of his death, and which has been more effectual than any other in making the nineteenth century illustrious, will form the subject of our subsequent articles.

G. J. R.

II.

WORK IN GEOLOGY.

NO man of his time has exercised upon the science of Geology a profounder influence than Charles Darwin. At an early period of his life he took much interest in geological studies, and in later years, while engaged in other pursuits, he kept himself acquainted with the progress that was being made in this department of natural knowledge. His influence upon it has been twofold, arising partly from the importance and originality of some of his own contributions to the literature of the science, but chiefly from the bearing of his work on other branches of natural history.

When he began to direct his attention to geological inquiry the sway of the Cataclysmal school of geology was still paramount. But already the Uniformitarians were gathering strength, and,

before many years were past, had ranged themselves under the banner of their great champion, Lyell. Darwin, who always recognised his indebtedness to Lyell's teaching, gave a powerful impulse to its general reception by the way in which he gathered from all parts of the world facts in its support. He continually sought in the phenomena of the present time the explanation of those of the past. Yet he was all the while laying the foundation on which the later or Evolutional school of geology has been built up.

Darwin's specially geological memoirs are not numerous, nor have they been of the same epoch-making kind as his biological researches. But every one of them bears the stamp of his marvellous acuteness in observation, his sagacity in grouping scattered facts, and his unrivalled far-reaching vision that commanded all their mutual bearings, as well as their place in the general economy of things. His long travels in the *Beagle* afforded him opportunities of making himself acquainted with geological phenomena of the most varied kinds. With the exception of one or two minor papers written in later years, it may be said that

all his direct contributions to geology arose out of the *Beagle* voyage. The largest and most important part of his geological work dealt with the hypogene forces of nature—those that are concerned in volcanoes and earthquakes, in the elevation of mountains and continents, in the subsidence of vast areas of the sea-bottom, and in the crumpling, foliation, and cleavage of the rocks of the earth's crust. His researches in these subjects were mainly embodied in the *Geology of the Voyage of the Beagle*—a work which, in three successive parts, was published under the auspices of the Lords of the Treasury.

The order chosen by Darwin for the subjects of these three parts probably indicates the relative importance with which they were regarded by himself. The first was entitled *The Structure and Distribution of Coral Reefs* (1842). This well-known treatise, the most original of all its author's geological memoirs, has become one of the recognised classics of geological literature. The origin of those remarkable rings of coral-rock in mid-ocean had given rise to much speculation, but no satisfactory solution of the problem had been proposed. After

visiting many of them, and examining also coral-reefs that fringe islands and continents, he offered a theory which for simplicity and grandeur strikes every reader with astonishment. It is pleasant after the lapse of many years to recall the delight with which one first read the *Coral Reefs*, how one watched the facts being marshalled into their places, nothing being ignored or passed lightly over, and how step by step one was led up to the grand conclusion of wide oceanic subsidence. No more admirable example of scientific method was ever given to the world, and even if he had written nothing else, this treatise alone would have placed Darwin in the very front of investigators of nature.

The second part was entitled *Geological Observations on the Volcanic Islands visited during the Voyage of H.M.S. Beagle, together with some Brief Notices on the Geology of Australia and the Cape of Good Hope* (1844). Full of detailed observations, this work still remains the best authority on the general geological structure of most of the regions it describes. At the time it was written, the "Crater of Elevation theory," though opposed by Constant, Prevost, Scrope, and Lyell, was generally accepted,

at least on the Continent. Darwin, however, could not receive it as a valid explanation of the facts, and though he did not adopt the views of its chief opponents, but ventured to propose a hypothesis of his own, the observations impartially made and described by him in this volume must be regarded as having contributed towards the final solution of the question.

The third and concluding part bore the title of *Geological Observations on South America* (1846). In this work the author embodied all the materials collected by him for the illustration of South American geology save some which had already been published elsewhere. One of the most important features of the book was the evidence which it brought forward to prove the slow, interrupted elevation of the South American Continent during a recent geological period. On the western sea-board he showed that beds of marine shells could be traced more or less continuously for a distance of upwards of 2,000 miles, that the elevation had been unequal, reaching in some places at least to as much as 1,300 feet;—that in one instance, at a height of 85 feet above the sea,

undoubted traces of the presence of man occurred in a raised beach, and hence that the land had there risen 85 feet since Indian man had inhabited Peru. These proofs of recent elevation may have influenced him in the conclusion which he drew as to the marine origin of the great elevated plains of Chili. But at that time there was a general tendency among British geologists to detect evidence of sea-action everywhere, and to ignore or minimise the action of running water and wind-drift upon the land. An important chapter of the volume, devoted to a discussion of the phenomena of cleavage and foliation, is well known to every student of the literature of metamorphism.

The official records of the *Beagle* did not, however, include all that Darwin wrote on the geology of the voyage. He contributed to the *Transactions* of the Geological Society (vol. v. 1840) a paper on the connection of volcanic phenomena. In the same publication (vi. 1842) appears another, on the erratic boulders of South America; while a third, on the geology of the Falkland Islands, was published later.

While dealing with the subterranean agents in geological change, he kept at the same time an ever watchful eye upon the superficial operations by which the surface of the globe is modified. He is one of the earliest writers to recognise the magnitude of the denudation to which even recent geological accumulations have been subjected. One of the most impressive lessons to be learnt from his account of Volcanic Islands is the prodigious extent to which they have been denuded. As just stated, he was disposed to attribute more of this work to the action of the sea than most geologists would now admit; but he lived himself to modify his original views, and on this subject his latest utterances are quite abreast of the time. It is interesting to note that one of his early geological papers was on the Formation of Mould (1840), and that after the lapse of forty years he returned to this subject, devoting to it the last of his volumes. In the first sketch we see the patient observation and shrewdness of inference so eminently characteristic of the writer, and in the finished work the same faculties enriched with the experience of a long and busy life. In bringing to light the

operations of the earthworm, he called the attention of geologists to an agency, the real efficiency of which they probably do not yet appreciate. Élie de Beaumont looked upon the layer of grass-covered soil as a permanent datum-line from which the denudation of exposed surfaces might be measured. But, as Darwin showed, the constant transference of soil from beneath to the surface, and the consequent exposure of the materials so transferred to be dried and blown away by wind, or to be washed to lower levels by rain, must tend slowly but certainly to lower the level even of undisturbed grass-covered land.

To another of his early papers reference may be made, from its interest in the history of British geology. Buckland, following in the footsteps of Agassiz, had initiated that prodigious amount of literature which has now been devoted to the records of the Glacial period in this country, by reading to the Geological Society a paper "On Diluvio-glacial Phenomena in Snowdonia and in adjacent parts of North Wales" (1841). Darwin, whose wanderings in South America had led him to study the problems presented by erratic blocks

took an early opportunity of visiting the Welsh district described by Buckland, and at once declared himself to be a believer in the former presence of glaciers in Britain. His paper (1843) in which this belief is stated and enforced by additional observations, stands almost at the top of the long list of English contributions to the history of the Ice Age.

The influence exercised upon the progress of geology by Darwin's researches in other than geological fields, is less easy to be appraised. Yet it has been far more widespread and profound than that of his direct geological work. Even as far back as the time of the voyage of the *Beagle*, he had been led to reflect deeply on some of Lyell's speculations upon the influence of geological changes on the geographical distribution of animals. From that time the intimate connection between geological history and biological progress seems to have been continually present in his mind. It was not, however, until the appearance of the *Origin of Species* in 1859 that the full import of his reflections was perceived. His chapter on the "Imperfection of the

Geological Record" startled geologists as from a profound slumber. It would be incorrect to say that he was the first to recognise the incompleteness of the record; but certainly until the appearance of that famous chapter the general body of geologists was blissfully unconscious of the essentially fragmentary character of the geological record. Darwin showed why this must necessarily be the case; how multitudes of organic types, both of the sea and of the land, must have decayed and never have been preserved in any geological deposit; how, even if entombed in such accumulations, they would in great measure be dissolved away by the subsequent percolation of water. Returning to some of his early speculations, he pointed out that massive geological deposits rich in fossils could only have been laid down during subsidence, and only where the supply of sediment was sufficient to let the sea remain shallow, and to entomb the organic remains on its floor before they had decayed. Hence, by the very conditions of its formation, the geological record, instead of being a continuous and tolerably complete chronicle, must be intermittent and fragmentary. The sudden appearance of whole groups

of allied species of fossils on certain horizons had been assumed by some eminent authorities as a fatal objection to any doctrine of the transmutation of species. But Darwin now claimed this fact as only another evidence of the enormous gaps in geological history. Reiterating again and again that only a small fraction of the world had been examined geologically, and that even that fraction was still but imperfectly known, he called attention to the history of geological discovery as furnishing itself a strong argument against those who reasoned as if the geological record were a full chronicle of the history of life upon the earth. There is a natural tendency to look upon the horizon upon which a fossil species first appears as marking its birth, and that on which it finally disappears as indicating its extinction. Darwin declared this assumption to be "rash in the extreme." No palæontologist or geologist will now gainsay this assertion. And yet how continually do we still hear men talking of the stages of the geological record, as if these were sharply marked off everywhere by the first appearance and final disappearance of certain species. The boldness with which Darwin challenged some of these long-rooted

beliefs is not less conspicuous than the modesty and deference with which his own suggestions were always given. "It is notorious," he remarked, "on what excessively slight differences many palæontologists have founded their species; and they do this the more readily if the specimens come from different sub-stages of the same formation."

Starting from this conception of the nature of the geological record, Darwin could show that the leading facts made known by palæontology could be explained by his theory of descent with modification through natural selection. New species had slowly come in, as old ones had slowly died out. Once the thread of succession had been broken it was never taken up again; an extinct species or group never reappeared, yet extinction was a slow and unequal process, and a few descendants of ancient types might be found lingering in protected and isolated situations. "We can understand how it is that all the forms of life, ancient and recent, make together one grand system; for all are connected by generation. From the continued tendency to divergence, the more ancient a form is, the more generally it differs from those now

living. The inhabitants of each successive period in the world's history have beaten their predecessors in the race for life, and are in so far, higher in the scale of nature; and this may account for that vague, yet ill-defined sentiment, felt by many palæontologists, that organisation on the whole has progressed. If it should hereafter be proved that ancient animals resemble to a certain extent the embryos of more recent animals of the same class, this fact will be intelligible."

Again, what a flood of fresh light was poured upon geological inquiry by the two chapters on Geographical Distribution in the *Origin of Species!* A new field of research, or, at least, one in which comparatively little had been yet attempted, was there opened out. The grouping of living organisms over the globe was now seen to have the most momentous geological bearings. Every species of plant and animal must have had a geological history, and might be made to tell its story of the changes of land and sea.

In fine, the spirit of Mr. Darwin's teaching may be traced all through the literature of science, even in departments which he never himself entered.

No branch of research has benefited more from the infusion of this spirit than geology. Time-honoured prejudices have been broken down, theories that seemed the most surely based have been reconsidered, and, when found untenable, have been boldly discarded. That the Present must be taken as a guide to the Past, has been more fearlessly asserted than ever. And yet it has been recognised that the present differs widely from the past, that there has been a progress everywhere, that Evolution and not Uniformitarianism has been the law by which geological history has been governed. For the impetus with which these views have been advanced in every civilised country, we look up with reverence to the loved and immortal name of Charles Darwin.

A. G.

III.

WORK IN BOTANY.

IN attempting to estimate the influence which Mr. Darwin's writings have exerted on the progress of botanical science, we must necessarily discriminate between the indirect effect which his views have had on botanical research generally, and the direct results of his own contributions. No doubt in a sense the former will seem in the retrospect to overshadow the latter. For in his later writings Mr. Darwin was content to devote himself to the consideration of problems which, in a limited field, brought his own theoretical views to a detailed test, and so may ultimately seem to be somewhat merged in them. Yet these writings can never fail to command our admiration even viewed apart from all else that Mr. Darwin did. It is wonderful enough that so great a master in biological science should, at an advanced age, have been content to work with all

the fervour and assiduity of youth at phenomena of vegetable life apparently minute and of the most special kind. To him, no doubt, they were not minute, but instinct with a significance that the professed botanical world had for the most part missed seeing in them failing the point of view which Mr. Darwin himself supplied. It is not too much to say that each of his botanical investigations, taken on its own merits, would alone have made the reputation of any ordinary botanist.

Mr. Darwin's attitude towards botany, as indeed to biological studies generally, was, it should always be remembered, in his early life essentially that of a naturalist of the school of Linnæus and Humboldt —a point of view unfortunately now perhaps a little out of fashion. Nature in all its aspects spoke to his feelings with a voice that was living and direct. The writer of these lines can well remember Mr. Darwin gently complaining that some of this warm enthusiasm for nature, as it presents itself unanalysed to ordinary healthy vision, seemed to be a little dulled in the younger naturalists of the day. The pages of the *Journal of Researches* show no such restraint, but abound with passages in which Mr.

Darwin's unstudied and simple language is carried by the force of warm impression and perfect joy in nature to a level of singular beauty. One passage may be quoted as an illustration; it is from the description of Bahia in chapter xxi.:—

"When quietly walking along the shady pathways, and admiring each successive view, I wished to find language to express my ideas. Epithet after epithet was found too weak to convey to those who have not visited the intertropical regions, the sensation of delight which the mind experiences. I have said that the plants in a hothouse fail to communicate a just idea of the vegetation, yet I must recur to it. The land is one great wild, untidy, luxuriant hothouse, made by Nature for herself, but taken possession of by man, who has studded it with gay houses and formal gardens. How great would be the desire in every admirer of nature to behold, if such were possible, the scenery of another planet! Yet to every person in Europe, it may be truly said, that at the distance of only a few degrees from his native soil, the glories of another world are opened to him. In my last walk I stopped again and again to gaze on these beauties, and endeavoured to fix in

my mind for ever, an impression which at the time I knew sooner or later must fail. The form of the orange-tree, the cocoa-nut, the palm, the mango, the tree-fern, the banana, will remain clear and separate; but the thousand beauties which unite these into one perfect scene must fade away; yet they will leave, like a tale heard in childhood, a picture full of indistinct, but most beautiful figures."

A spirit such as this, penetrating an intelligence such as Mr. Darwin's, would not content itself with the superficial interest of form and colour. These, in his eyes, were the outward and visible signs of the inner secrets. The fascination of sense which the former imposed upon him but stimulated his desire to unveil the latter. In the Galapagos we are not then surprised to find him ardently absorbed in the problems which the extraordinary distribution of the plants, no less than of other organisms, presented:— "I indiscriminately collected," he says, "everything in flower on the different islands, and fortunately kept my collections separate."

After tabulating the results which they yielded after systematic determination, he proceeds:—

"Hence we have the truly wonderful fact, that in

James Island, of the thirty-eight Galapageian plants, or those found in no other part of the world, thirty are exclusively confined to this one island; and in Albemarle Island, of the twenty-six aboriginal Galapageian plants, twenty-two are confined to this one island, that is, only four are known to grow on the other islands of the Archipelago; and so on, as shown in the above table, with the plants from Chatham and Charles Island."

It is impossible in reading the *Origin of Species* not to perceive how deeply Mr. Darwin had been impressed by the problems presented by such singularities of plant distribution as he met with in the Galapagos. And of such problems up to the time of its publication no intelligible explanation had seemed possible. Sir Joseph Hooker had indeed prepared the ground by bringing into prominence, in numerous important papers, the no less striking phenomena which were presented when the vegetation of large areas came to be analysed and compared. No one therefore could estimate more justly what Mr. Darwin did for those who worked in this field. How the whole theory of the geographical *distribution* of plants stood after the publication of

the *Origin of Species* cannot then be better estimated than from the summary of the position, contained in Sir Joseph Hooker's recent Address to the Geographical Section of the meeting of the British Association at York.

"Before the publication of the doctrine of the origin of species by variation and natural selection, all reasoning on their distribution was in subordination to the idea that these were permanent and special creations; just as, before it was shown that species were often older than the islands and mountains they inhabited, naturalists had to make their theories accord with the idea that all migration took place under existing conditions of land and sea. Hitherto the modes of dispersion of species, genera, and families had been traced, but the origin of representative species, genera, and families, remained an enigma; these could be explained only by the supposition that the localities where they occurred presented conditions so similar that they favoured the creation of similar organisms. But this failed to account for representation occurring in the far more numerous cases where there is no discoverable similarity of physical conditions, and

of their not occurring in places where the conditions are similar. Now under the theory of modification of species after migration and isolation, their representation in distant localities is only a question of time and changed physical conditions. In fact, as Mr. Darwin well sums up, all the leading facts of distribution are clearly explicable under this theory; such as the multiplication of new forms, the importance of barriers in forming and separating zoological and botanical provinces; the concentration of related species in the same area; the linking together under different latitudes of the inhabitants of the plains and mountains, of the forests, marshes, and deserts, and the linking of these with the extinct beings which formerly inhabited the same areas; and the fact of different forms of life occurring in areas having nearly the same physical conditions."

If Mr. Darwin had done no more than this for botanical science he would have left an indelible mark on its progress. But the consideration of the various questions which the problem of the origin of species presented led him into other inquiries in which the results were scarcely less important. The key-note of a whole series of his writings is struck

by the words with which the eighth chapter of the *Origin of Species* commences:—

"The view generally entertained by naturalists is that species, when intercrossed, have been specially endowed with the quality of sterility, in order to prevent the confusion of all organic forms."

The examination of this principle necessarily obliged him to make a profound study of the conditions and limits of sterility. The results embodied in his well-known papers on dimorphic and trimorphic plants afforded an absolutely conclusive proof that sterility was not inseparably tied up with specific divergence. But the question is handled in the most cautious way, and when the reader of the chapter on hybridism arrives at the concluding words, in which Mr. Darwin declares that on this ground "there is no fundamental distinction between species and varieties," he finds himself in much the same intellectual position as is produced by the Q.E.D. at the end of a geometrical demonstration.

It was characteristic of Mr. Darwin's method of study to follow up on its own account, as completely as possible, when opportunity presented, any side issue which had been raised apparently incidentally

in other discussions. Indeed, it was never possible to guess what amount of evidence Mr. Darwin had in reserve behind the few words which marked a mere step in an argument. It is from his practice of bringing out from time to time the contents of his unseen treasure-house that we gain some insight into the scientific fertility of his later years, at first sight so inexplicably prolific. Many of his works published during that period may be properly regarded in the light of disquisitions on particular points of his great theory. The researches on the sexual phenomena of heterostyled plants, alluded to above, which were communicated to the Linnean Society in a series of papers ranging over the years 1862-8, ultimately found their complete development in the volume *On the Different Forms of Flowers on Plants of the same Species*, published in 1877. In the same way, the statement in the *Origin of Species*, that "the crossing of forms only slightly differentiated favours the vigour and fertility of their offspring," finds its complete expansion in *The Effects of Cross and Self-Fertilisaton in the Vegetable Kingdom*, published in 1876.

The *Origin of Species* in the form in which

it has become a classic in scientific literature was originally only intended as a preliminary *précis* of a vast accumulation of facts and arguments which the author had collected. It was intended to be but the precursor of a series of works in which all the evidence was to be methodically set out and discussed. Of this vast undertaking only one portion, the *Variation of Plants and Animals under Domestication*, was ever actually published. Apart from its primary purpose it produced a profound impression, especially on botanists. This was partly due to the undeniable force of the argument from analogy stated in a sentence in the introduction: "Man may be said to have been trying an experiment on a gigantic scale; and it is an experiment which nature, during the long lapse of time, has incessantly tried." But it was still more due to the unexpected use of the vast body of apparently trivial facts and observations which Mr. Darwin with astonishing industry had disinterred from weekly journals and ephemeral publications of all sorts and unexpectedly forced into his service. Like Molière's Monsieur Jourdain, who was delighted to find that he had been unwittingly talking prose all his life, horti-

culturists who had unconsciously moulded plants almost at their will at the impulse of taste or profit were at once amazed and charmed to find that they had been doing scientific work and helping to establish a great theory. The criticism of practical men, at once most tenacious and difficult to meet, was disarmed; these found themselves hoist with their own petard. Nor was this all. The exclusive province of science was in biological phenomena for ever broken down; every one whose avocations in life had to do with the rearing or use of living things, found himself a party to the "experiment on a gigantic scale," which had been going on ever since the human race withdrew for their own ends plants or animals from the feral and brought them into the domesticated state.

Mr. Darwin with characteristic modesty had probably underrated the effect which the *Origin of Species* would have as an argumentative statement of his views. When he came to realise this, it probably seemed to him unnecessary to submit to the labour of methodising the vast accumulations which he had doubtless made for the second *and third* instalments of the detailed exposition

of the evidence which he had promised. As was hinted at the commencement, his attention was rather drawn away from the study of evidence already at the disposal of those who cared to digest and weigh it, to the exploration of the field of nature with the new and penetrating instrument of research which he had himself forged. Something too must be credited to the intense delight which he felt in investigating the phenomena of living things. But he doubtless saw that the work to be done was to show how morphological and physiological complexity found its explanation from the principle of natural selection. This is the idea which is ever dominant. Thus he concludes his work on climbing plants: "It has often been vaguely asserted that plants are distinguished from animals by not having the powers of movement. It should rather be said that plants acquire and display this power only when it is of some advantage to them; this being of comparatively rare occurrence, as they are affixed to the ground, and food is brought to them by the air and rain." The diversity of the power of movement in plants naturally engaged his attention, and the last but one of his works—

in some respects perhaps the most remarkable of his botanical writings—was devoted to showing that this diversity could be regarded as derived from a single fundamental property: "All the parts or organs of every plant while they continue to grow . . . are continually circumnutating." Whether this masterly conception of the unity of what has hitherto seemed a chaos of unrelated phenomena will be sustained time alone will show. But no one can doubt the importance of what Mr. Darwin has done in showing that for the future the phenomena of plant movement can and indeed must be studied from a single point of view.

Along another line of work Mr. Darwin occupied himself with showing what aid could be given by the principle of natural selection in explaining the extraordinary structural variety exhibited by plant morphology. The fact that cross-fertilisation was an advantage, was the key with which, as indicated in the pages of the *Origin of Species*, the bizarre complexities of orchid flowers could be unlocked. The detailed facts were set out in a well-known work, and the principle is now generally accepted with regard to flowers generally. The work on

insectivorous plants gave the results of an exploration similar in its object, and bringing under one common physiological point of view a variety of the most diverse and most remarkable modifications of leaf-form.

In the beginning of these remarks the attempt has already been made to do justice to the mark Mr. Darwin has left on the modern study of geographical botany (and that implies a corresponding influence on phyto-palæontology). To measure the influence which he has had on any other branches of botany, it is sufficient to quote again from the *Origin of Species:* "The structure of each part of each species, for whatever purpose used, will be the sum of the many inherited changes through which that species has passed during its successive adaptations to changed habits and conditions of life." These words may almost be said to be the key-note of Sachs's well-known text-book, which is the most authoritative modern exposition of the facts and principles of plant-structure and function; and there is probably not a botanical class-room or work-room in the civilised world where they are not the animating principle of both instruction and research.

Notwithstanding the extent and variety of his botanical work, Mr. Darwin always disclaimed any right to be regarded as a professed botanist. He turned his attention to plants doubtless because they were convenient objects for studying organic phenomena in their least complicated forms; and this point of view, which, if one may use the expression without disrespect, had something of the amateur about it, was in itself of the greatest importance. For, from not being, till he took up any point, familiar with the literature bearing on it, his mind was absolutely free from any prepossession. He was never afraid of his facts or of framing any hypothesis, however startling, which seemed to explain them. However much weight he attributed to inheritance as a factor in organic phenomena, tradition went for nothing in studying them. In any one else such an attitude would have produced much work that was crude and rash. But Mr. Darwin—if one may venture on language which will strike no one who had conversed with him as overstrained—seemed by gentle persuasion to have penetrated that reserve of nature which baffles smaller men. In other words, his long *experience* had given him a kind of instinctive

insight into the method of attack of any biological problem, however unfamiliar to him, while he rigidly controlled the fertility of his mind in hypothetical explanations by the no less fertility of ingeniously-devised experiment. Whatever he touched, he was sure to draw from it something that it had never before yielded, and he was wholly free from that familiarity which comes to the professed student in every branch of science, and blinds the mental eye to the significance of things which are overlooked because always in view.

The simplicity of Mr. Darwin's character pervaded his whole method of work. Alphonse de Candolle visited him in 1880 and felt the impression of this: "He was not one of those who would construct a palace to lodge a laboratory. I sought out the greenhouse in which so many admirable experiments had been made on hybrids. It contained nothing but a vine." There was no affectation in this. Mr. Darwin provided himself with every resource which the methods of the day or the mechanical ingenuity of his sons could supply, and when it had served its purpose it was discarded. Nor had he any pre-possession in favour of one kind of scientific work

more than another. His scientific temperament was thoroughly catholic and sympathetic to anything which was not a mere regrinding of old scientific dry bones. He would show his visitors an *Epipactis* which for years came up in the middle of one of his gravel walks with almost as much interest as some new point which he had made out in a piece of work actually in hand. And though he had long abandoned any active interest in systematic work, only a few months before his death he had arranged to provide funds for the preparation of the new edition of Steudel's Nomenclator,[1] which, at his earnest wish, has been projected at Kew.

[1] An enumeration of the names and synonyms of all described flowering plants with their native countries.

W. T. T. D.

IV.

WORK IN ZOOLOGY.

THE influence which our great naturalist has exerted upon zoology is unquestionably greater than that which has been exerted by any other individual; and as it depends on his generalisations much more than upon his particular researches, we may best do justice to it by taking a broad view of the effects of Darwinism on zoology, rather than by detailing those numberless facts which have been added to the science by the ever vigilant observations of Darwin. Nevertheless, we may begin our survey by enumerating the more important results of his purely zoological work, not so much because these have been rarely equalled by the work of any other zoologist, as because we may thus give due prominence to the remarkable association of qualities which was presented by Mr. Darwin's mind. This

association of qualities was such that he was able fully to appreciate and successfully to cultivate every department and ramification of biological research—whether morphological, physiological, systematic, descriptive, or statistical—and at the same time to rise above the *minutiæ* of these various branches, to take those commanding views of the whole range of nature and of natural science which have produced so enormous a change upon our means of knowledge and our modes of thought. No labourer in the field of science has ever plodded more patiently through masses of small detail; no master-mind on the highest elevation of philosophy has ever grasped more world-transforming truth.

Taking the purely zoological work in historical order, we have first to consider the observations made during the voyage of the *Beagle*. These, however, are much too numerous and minute to admit of being here detailed. Among the most curious are those relating to the scissor-beak bird, niata cattle, aëronaut spiders, upland geese, sense of sight and smell in vultures; and among the most important are those relating to the geographical distribution of species. The results obtained

on the latter head are of peculiar interest, inasmuch as it was owing to them that Mr. Darwin was first led to entertain the idea of evolution. As displaying the dawn of this idea in his mind we may quote a passage or two from his *Voyage of a Naturalist*, where these observations relating to distribution are given:—

"These mountains (the Andes) have existed as a great barrier since the present races of animals have appeared, and therefore, unless we suppose the same species to have been created in two different places, we ought not to expect any closer similarity between the organic beings on the opposite sides of the Andes, than on the opposite shores of the ocean."

"The natural history of these islands (of the Galapagos Archipelago) is eminently curious, and well deserves attention. Most of the organic productions are aboriginal creations, found nowhere else; there is even a difference between the inhabitants of the different islands; yet all show a marked relationship with those of America, though separated from that continent by an open space of ocean between 500 and 600 miles in width. The Archipelago is a little world within itself, or rather a

satellite attached to America, whence it has derived a few stray colonists, and has received the general character of its indigenous productions. Considering the small size of the islands, we feel astonished at the number of their aboriginal beings, and at their confined range. Seeing every height crowned with its crater, and the boundaries of most of the lava-streams still distinct, we are led to believe that within a period, geologically recent, the unbroken ocean was here spread out. Hence, both in space and time, we seem to be brought somewhat near to that fact—that mystery of mysteries—the first appearance of new beings on this earth."

Next in order of time we have to notice the *Monograph of the Cirripedia.* This immensely elaborate work was published by the Ray Society in two volumes, comprising together over 1,000 large octavo pages, and 40 plates. These massive books (which were respectively published in 1851 and 1854) convey the results of several years of devoted inquiry, and are particularly interesting, not only on account of the intrinsic value of the work, but also because they show that Mr. Darwin's powers of research were not less remarkable in the direction

of purely anatomical investigation than they were in that of physiological experiment and philosophical generalisation. No one can even glance through this memoir without perceiving that if it had stood alone it would have placed its author in the very first rank as a morphological investigator. The prodigious number and minute accuracy of his dissections, the exhaustive detail with which he worked out every branch of his subject—sparing no pains in procuring every species that it was possible to procure, in collecting all the known facts relating to the geographical and geological distribution of the group, in tracing the complicated history of metamorphoses presented by the individuals of the sundry species, in disentangling the problem of the homologies of these perplexing animals, &c.—all combine to show that had Mr. Darwin chosen to devote himself to a life of purely morphological work, his name would probably have been second to none in that department of biology. We have to thank his native sagacity that such was not his choice. Valuable as without any question are the results of the great anatomical research which we are considering, we cannot peruse these thousand

pages of closely-written detail without feeling that, for a man of Mr. Darwin's exceptional powers, even such results are too dearly bought by the expenditure of time required for obtaining them. We cannot, indeed, be sorry that he engaged upon and completed this solid piece of morphological work, because it now stands as a monument to his great ability in this direction of inquiry; but at the same time we feel sincerely glad that the conspicuous success which attended the exercise of such ability in this instance did not betray him into other undertakings of the same kind. Such undertakings may suitably be left to establish the fame of great though lesser men; it would have been a calamity in the history of our race if Charles Darwin had been tempted by his own ability to become a comparative anatomist.

But as we have said—and we repeat it lest there should be any possibility of mistaking what we mean—the results which attended this laborious inquiry were of the highest importance to comparative anatomy, and of the highest interest to comparative anatomists. The limits of this article do *not admit of our* giving a summary of these results,

so we shall only allude to the one which is most important. This is the discovery of the "Complemental Males." The manner in which this discovery was made in its entirety is of interest, as showing the importance of remembering apparently insignificant observations which may happen to be incidentally made during the progress of a research. For Mr. Darwin writes:—

"When first dissecting *Scalpellum vulgare*, I was surprised at the almost constant presence of one or more very minute parasites, on the margins of both scuta, close to the umbones. I carelessly dissected one or two specimens, and concluded that they belonged to some new class or order amongst the Articulata, but did not at the time even conjecture that they were Cirripedes. Many months afterwards, when I had seen in Ibla that an hermaphrodite could have a complemental male, I remembered that I had been surprised at the small size of the vesiculæ seminales in the hermaphrodite *S. vulgare*, so that I resolved to look with care at these parasites; on doing so I now discovered that they were Cirripedes, for I found *that they* adhered by cement, and were furnished

with prehensile antennæ, which latter, I observed with astonishment, agreed in every minute character, and in size, with those of *S. vulgare*. I also found that these parasites were destitute of a mouth and stomach; that consequently they were short-lived but that they reached maturity; and that all were males. Subsequently five other species of the genus Scalpellum were found to present more or less closely analogous phenomena. These facts, together with those given under Ibla (and had it not been for this latter genus, I never probably should have struck on the right line in my investigation), appear sufficient to justify me in provisionally considering the truly wonderful parasites of the several species of Scalpellum, as Males and Complemental Males" (vol. i. pp. 292-3).

The remarkable phenomena of sexuality in these animals is summed up thus:—

"The simple fact of the diversity in the sexual relations displayed within the limits of the genera Ibla and Scalpellum, appears to me eminently curious. We have (1) a female, with a male (or rarely two) permanently attached to her, protected by her, and nourished by any minute animals which

may enter her sac; (2) a female, with successive pairs of short-lived males, destitute of mouth and stomach, inhabiting the pouches formed on the under sides of her two valves; (3) an hermaphrodite, with from one or two, up to five or six, similar short-lived males without mouth or stomach, attached to one particular spot on each side of the orifice of the capitulum; and (4) hermaphrodites, with occasionally one, two, or three males, capable of seizing and devouring their prey in the ordinary Cirripedal method, attached to two parts of the capitulum, in both cases being protected by the closing of the scuta."

With reference to these Complemental Males (so called "to show that they do not pair with a female, but with a bisexual individual") Mr. Darwin further observes: "Nothing strictly analogous is known in the animal kingdom; but amongst plants, in the Linnean class Polygamia, closely similar instances abound;" and also that "in the series of facts now given we have one curious illustration more to the many already known, how gradually nature changes from one condition to the other, in this case from bisexuality to unisexuality" (ii. 29).

Lastly, to give only one other quotation from this work, he writes:—

"As I am summing up the singularity of the phenomena here presented, I will allude to the marvellous assemblage of beings seen by me within the sac of an *Ibla quadrivalvis*, namely, an old and young male, both minute, worm-like, destitute of a capitulum, with a great mouth and rudimentary thorax and limbs, attached to each other and to the hermaphrodite, which latter is utterly different in appearance and structure; secondly, the four or five free, boat-shaped larvæ, with their curious prehensile antennæ, two great compound eyes, no mouth, and six natatory legs; and lastly, several hundreds of the larvæ, in their first stage of development, globular, with horn-shaped projections on their carapaces, minute single eyes, filiform antennæ, proboscíform mouths, and only three pairs of natatory legs. What diverse beings, with scarcely anything in common, and yet all belonging to the same species!" (i. 293).

Scattered through the *Origin of Species*, the *Variation of Plants and Animals under Domestication*, and the *Descent of Man*, we meet with many purely

zoological observations of much interest and importance as such, or apart from their bearing on the general principles and arguments for the illustration or fortification of which they are introduced. In this connection we may particularly allude to the chapters on Variability, Hybridism, and Geographical Distribution—chapters which contain such a large number of new facts, as well as new groupings of old ones, that we cannot undertake to epitomise them in a *résumé* of Mr. Darwin's work so brief as the present. Nor should we forget to mention in the present connection his experimental proof of the manner in which bees make their hexagonal cells, and of the important part played in the economy of nature by earthworms. Moreover, the hypothesis of sexual selection necessitated the collection of a large body of facts relating to the ornamentation of all classes of animals, from insects and crustacea upwards; and whatever we may think about the stability of the hypothesis, there can be no question, from a zoological point of view, concerning the value of this collection of facts as such.

But without waiting to consider further the purely

zoological results presented by the work before us, we must turn to consider the effects of this work upon zoological science itself. And here we approach the true magnitude of Darwin as a zoologist. Of very few men in the history of our race can it be said that they not only enlarged science, but changed it—not only added facts to the growing structure of natural knowledge, but profoundly modified the basal conceptions upon which the whole structure rested; and of no one can this be said with more truth than it can be said of Darwin. For although it is the case that the idea of evolution had occurred to other minds—in two or three instances with all the force of full conviction—it is no less certainly the case that the idea proved barren. Why did it prove so? Because it had never before been fertilised by the idea of natural selection. To demonstrate, or to render sufficiently probable by inference, the *fact* of evolution (for direct observation of the process is from the nature of the case impossible), required some reasonable suggestion as to the *cause* of evolution, such as is supplied by the theory of natural selection; and when once this *suggestion* was forthcoming, it mattered little whether

it was considered as propounding the only, the chief, or but a subordinate cause; all that was needed to recommend the evidence of evolution to the judgment of science was the discovery of *some* cause which could be reasonably regarded as not incommensurate with *some* of the effects ascribed to it. And, unlike the desperate though most laudable groupings of Lamarck, the simple solution furnished by Darwin was precisely what was required to give a *locus standi* to the evidence of descent.

But we should form a very inadequate estimate of the services rendered to science by Mr. Darwin if we were to stop here. The few general facts out of which the theory of evolution by natural selection is formed—viz. struggle for existence, survival of the fittest, and heredity — were all previously well-known facts; and we may not unreasonably feel astonished that so apparently obvious a combination of them as that which occurred to Mr. Darwin should have occurred to no one else, with the single exception of Mr. Wallace. The fact that it did not do so is most fortunate in two respects—first, because it gave Mr. Darwin the opportunity of pondering upon the subject *ab initio*, and next because it gave

the world an opportunity of witnessing the disinterested unselfishness which has been so signally and so consistently displayed by both these English naturalists. But the greatness of Mr. Darwin as the reformer of biology is not to be estimated by the fact that he conceived the idea of natural selection; his claim to everlasting memory rests upon the many years of devoted labour whereby he tested this idea in all conceivable ways—amassing facts from every department of science, balancing evidence with the soundest judgment, shirking no difficulty, and at last astonishing the world as with a revelation by publishing the completed proof of evolution. Indeed, so colossal is Mr. Darwin's greatness in this respect, that we doubt whether there ever was a man so well fitted to undertake the work which he has so successfully accomplished. For this work required not merely vast and varied knowledge of many provinces of science, and the very exceptional powers of judgment which Mr. Darwin possessed, but also the patience to labour for many years at a great generalisation, the honest candour which rendered the author his own best critic, and last, though perhaps not least, the magnanimous simplicity of character which,

in rising above all petty and personal feelings, delivered a thought-reversing doctrine to mankind with as little disturbance as possible of the deeply-rooted sentiments of the age. In the chapter of accidents, therefore, it is a singularly fortunate coincidence that Mr. Darwin was the man to whom the idea of natural selection occurred; for although in a generation or two the truth of evolution might have become more and more forced upon the belief of science, and with it the acceptance of natural selection as an operating cause, in our own generation this could only have been accomplished in the way that it was accomplished; we required one such exceptional mind as that of Darwin to focus the facts, and to show the method.

It seems almost needless to turn from this aspect of our subject to enlarge upon the influence which a general acceptance of the theory of descent has had upon biology. We do not state the case too strongly when we say that this has been the influence which has created organisation out of confusion, brought the dry bones to life, and made all the previously dissociated facts of science stand up as an exceeding great army. Let any one turn to the eloquent

prophecy with which the pages of the *Origin of Species* terminate—a prophecy which sets forth in order the transforming effect that the doctrine of evolution would in the future exert upon every department of biology—and he may rejoice to think that Mr. Darwin himself lived to see every word of that prophecy fulfilled. For where is now the "systematist . . . incessantly haunted by the shadowy doubt whether this or that form be a true species"? And has it not proved that "the other and more general departments of natural history will rise greatly in interest—that the terms used by naturalists, of affinity, relationship, community of type, paternity, morphology, adaptive characters, rudimentary and aborted organs, &c., will cease to be metaphorical, and will have a plain signification"? Do we not indeed begin to feel that "we no longer look at an organic being as a savage looks at a ship, as something wholly beyond his comprehension? and when we regard every production of nature as one which has had a long history, when we contemplate every complete structure and instinct as the summing up of many contrivances, each useful to the possessor, in the same way as any great

mechanical invention is the summing up of the labour, the experience, the reason, and even the blunders of numerous workmen, when we thus view each organic being," may we not now all say with Darwin, "How far more interesting—I speak from experience—does the study of natural history become"? And may we not now all see that "a grand and almost untrodden field of inquiry on the laws of variation, on correlation, on the effects of use and disuse, on the direct action of external conditions" *has* been opened up; that our classifications *have* become "as far as they can be made so, genealogies, and truly give what may be called a plan of creation;" that rules of classifying *do* "become simpler when we have a definite object in view;" and that "aberrant species, which may fancifully be called living fossils," actually *are* of service in supplying "a picture of ancient forms of life"? And again, must we not agree that "when we can feel assured that all the individuals of the same species and all the closely-allied species of most genera, have, within a not very remote period, descended from one parent, and have migrated from some one birthplace; and when we better know the many means of migration,

then, by the light which geology now throws, and will continue to throw, on former changes of climate and of the level of the land, we shall surely be able to trace in an admirable manner the former migrations of the inhabitants of the whole world"? And who is now able to question that "by comparing the differences between the inhabitants of the sea on the opposite sides of a continent, and of the various inhabitants on that continent in relation to their apparent means of migration, some light can be thrown on ancient geography"? Or, if we turn to "the noble science of geology," do we not see that we are beginning "to gauge with some security the duration of intervals by a comparison of the preceding and succeeding forms of life"? And last, though not least, have we not found this one short sentence so charged with meaning that a new and extensive science, second in importance to none, may be almost said to have grown out of what it states: —"Embryology will often reveal to us the structure, in some degree obscured, of the prototypes"?

If the progress of science during the last two-and-twenty years has in so astonishing a measure *verified* the prophecy of the *Origin of Species*,

surely, in conclusion, we are more than ever constrained to agree with the sentiments expressed by its closing words: "When I view all beings, not as special creations, but as the lineal descendants of some few beings which lived long before the first bed of the Cambrian system was deposited, they seem to me to become ennobled. . . . There is grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being evolved."

G. J. R.

V.

WORK IN PSYCHOLOGY.

THE effects upon Psychology of Mr. Darwin's writings have been so immense, that we shall not overstate them by saying that they are fully comparable with those which we have previously considered as having been exerted by the same writings on geology, botany, and zoology. This fact at first sight can scarcely fail to strike us as remarkable, in view of the consideration that Mr. Darwin was not only not himself a psychologist, but had little aptitude for, and perhaps less sympathy with, the technique of psychological method. The whole constitution of his mind was opposed to the subtlety of the distinctions and the mysticism of the conceptions which this technique so frequently involves; and therefore he was accustomed to regard the *problems* of mind in the same broad and general

light that he regarded all the other problems of nature. But if at first sight we are inclined to feel surprised that, although possessing none of the special mental equipments of a psychologist, he should have produced so enormous an influence upon psychology, our surprise must vanish when we consider the matter a little more attentively. For the truth of this matter is that psychology, in being the science furthest removed from the reach of experimental means and inductive method, is the science which has longest remained in the trammels of *a priori* analysis and metaphysical thought; therefore Darwin, by casting the eye of a philosophical naturalist upon the facts, without reference to the cobwebs which the specialists had woven around them, was able to gather directly much new information as to their meaning. And the rare sagacity with which he observed and reflected upon the phenomena of mind merely as phenomena or facts of nature, led to the remarkable results which we shall presently have to consider—results which have done more than any other to unmuffle the young science of psychology from the swaddling clothes of its mediæval nursery.

The portions of Mr. Darwin's writings which refer to mental science are very limited in extent—comprising, in fact, only one chapter in the *Origin of Species*, three in the *Descent of Man*, and a short paper on the development of infantile intelligence. The importance of the effect produced by them is therefore rendered all the more remarkable; but in this connection it seems desirable to state that the chapters to which we have alluded represent, in an exceedingly condensed form, the result of extensive thought and reading. A year or two ago Mr. Darwin lent the present writer the original drafts of these essays, together with all the notes and memoranda which he had collected on psychological subjects during the previous forty years, and so we can testify that any one who reads these MSS. is more likely to be surprised at the amount of labour which they indicate than at the effect which has been produced by the compressed publication of its results. What strikes one most in reading the MSS. is that which also strikes one most in reading the published *résumé* that has grown out of them—namely, the honest adherence throughout to *the strictly* scientific, or, as the followers of Comte

would say, positive method of seeking and interpreting facts; speculation, hypothesis, and straw-splitting are everywhere, not so much intentionally avoided, as alien to the whole conception of the manner in which the sundry problems are to be attacked. We all know that this conception has not met with universal approval—that more than one writer, adhering to the traditional methods of psychological inquiry, has expressly joined issue upon it. But although it is an easy matter for a technical psychologist to point to an absence of technical thought, and so of a recognition of technical principles, in these parts of Mr. Darwin's writings, we are persuaded that the *exposé* only serves to reveal a beam in the eye of the technical psychologist which prevents him from seeing clearly how to remove the mote from Mr. Darwin's. In other words, although it is true that Mr. Darwin does not recognise the niceties of distinction which seem so important to what we may term the professional mind, it is no less true that in the cases to which we have alluded, the professional mind has failed in its duty of filling up for itself the technical *lacunæ* in Mr. Darwin's expositions. Such *lacunæ* no doubt occur, but they never really

vitiate the integrity of the conclusions; and a trained psychologist would best fulfil his function as an under-builder, by supplying here and there the stones which the hand of the master has neglected to put in. To ourselves it always seems one of the most wonderful of the many wonderful aspects of Mr. Darwin's varied work, that by the sheer force of some exalted kind of common sense, unassisted by any special acquaintance with psychological method, he should have been able to strike, as it were, straight down upon some of the most important truths which have ever been brought to light in the region of mental science. These we shall now proceed to consider.

The chapter in the *Origin of Species* to which we have referred, is occupied chiefly with an application of the theory of natural selection to the phenomena of instinct, and in our opinion it has done more than all other psychological writings put together to explain what instinct is, why it is and how it came to be. Before this chapter was published, the only scientific theory concerning the origin of instincts that had been formed was the theory which regarded them as hereditary habits.

Because we know that in the individual intelligent adjustments become, by frequent repetition, automatic, it was inferred that the same might be true of the species, and therefore that all instincts were to be regarded as what Lewes has aptly termed "lapsed intelligence." In this view there is, without any question, much truth, and the first thing we have to notice about Mr. Darwin's writings with reference to instinct is that they not only recognised this truth, but, by elucidating the whole subject of heredity, placed it in a much clearer light than it ever stood before. Mr. Darwin, however, carried the philosophy of the subject very much further when he argued that, in conjunction with the cause formulated as "lapsing intelligence," there was another at least as potent in the formation of instincts — namely, natural selection. His own statement of the case is so terse that we cannot do better than quote it.

"If Mozart, instead of playing the pianoforte at three years with wonderfully little practice, had played a tune with no practice at all, he might truly be said to have done so instinctively. But it would be a serious error to suppose that the greater number

of instincts have been acquired by habit in one generation, and then transmitted by inheritance to succeeding generations. It can be clearly shown that the most wonderful instincts with which we are acquainted, namely, those of the hive-bee and of many ants, could not possibly have been acquired by habit.[1]

"It will be universally admitted that instincts are as important as corporeal structures for the welfare of each species, under its present conditions of life. Under changed conditions of life, it is at least possible that slight modifications of instinct might be profitable to a species; and if it can be shown that instincts do vary ever so little, then I can see no difficulty in natural selection preserving and continually accumulating variations of instinct to any extent that was profitable. It is thus, I believe, that all the most complex and wonderful instincts have originated."

Briefly, then, in Mr. Darwin's view, instincts may

[1] Because the individuals which exhibit them, being neuters, can never have progeny. It is indeed surprising, as Mr. Darwin further on observes, that no one previously "advanced this demonstrative case of neuter insects against the well-known doctrine of inherited habit as advanced by Lamarck."

arise by lapsing intelligence, by natural selection of accidental and possibly non-intelligent variations of habit, or by both principles combined—seeing that "a little dose of judgment" is often commingled with even the most fixed (or most strongly inherited) instincts. One good test of the truth of the view as a whole is that which Mr. Darwin has himself supplied — namely, searching through the whole range of instincts to see whether any occur which are either injurious to the animals exhibiting them, or beneficial only to other animals. Now there is really no authentic case of the former, and the latter are so few in number that they may reasonably be regarded, either as rudiments of instincts once useful (so analogous to the human tail), or as still useful in some unobservable manner (so analogous to the tail of the rattlesnake). The case of aphides secreting honey-dew for the benefit of ants occurred to Mr. Darwin as one which might be adduced against his theory in this connection, and he therefore made some experiments upon the subject, which led him to conclude that "as the excretion is extremely viscid, it is no doubt a convenience to the aphides to have it removed; therefore probably

they do not excrete solely for the good of the ants."

A discussion of the variability of instinct, and of the probability that variations should be inherited, leads him to consider the important case of the apparent formation of artificial instincts in our domestic dogs by continued training with selection, and also the not less important case of the effects produced upon natural instincts by the long-continued change of environment to which other of our domestic animals have been exposed. All the facts adduced as resulting from these long-continued though unintentional experiments by man, go to substantiate, in a very unmistakable manner, the theory concerning the origin and development of instincts which we are considering. The chapter concludes with a close consideration of some of the more remarkable instincts which occur in the animal kingdom, such as the parasitic instinct of the cuckoo, the slave-making instinct of ants, and the cell-making instinct of bees. A flood of light is thrown upon the latter, and the old-standing problem as to how the bees have come to make their cells in the form which requires the smallest amount of material for

their construction, while affording the largest capacity for purposes of storage, is solved.

From this brief account of the chapter on "Instinct," it is evident that the new idea which it starts, and in several directions elaborates, is an idea of immense importance to psychology, and that the broad marks or general principles laid down by it afford large scope for a further filling-in of numberless details by the attentive observation of facts. The phenomena of instinct, indeed, cease to be rebellious to explanation, and range themselves in orderly array under the flag of science.

But not less important than the chapter on "Instinct" are the chapters in the *Descent of Man* on the mental powers of man as compared with those of the lower animals, on the moral sense, and on the development of both during primæval and civilised times. Our estimate of the value of these chapters is so high that we gladly endorse the opinion of the late Prof. Clifford—who was no mean judge upon such matters—when he writes of them as presenting to his mind "the simplest, and clearest, and most profound philosophy that was ever written *upon the* subject." As the three chapters together

cover only eighty pages, it seems needless to render an abstract of them, so we shall only observe that although it is easy to show in them, as Mr. Mivart and others have shown, a want of appreciation of technical terms, and even of Aristotelian ideas nowhere in the whole range of Mr. Darwin's writings is his immense power of judicious generalisation more conspicuously shown. So much is this the case, that in studying these chapters we have ourselves always felt glad that Mr. Darwin was not the specialist in psychology which some of his critics seem to suppose that he ought to have been if he presumed to shake their science to its base; had he been such a specialist the great sweep of his thought might have been hindered by comparatively immaterial details.

Of the three chapters which we are considering, the most important is the one on the moral sense. As he himself says :—

"This great question (the origin of the moral sense) has been discussed by many writers of consummate ability; and my only excuse for touching upon it, is the impossibility of here passing it over; and because, so far as I know, no one has approached

it exclusively from the side of natural history. The investigation possesses, also, some independent interest, as an attempt to see how far the study of the lower animals throws light on one of the highest psychical faculties of man."

The result of this investigation and study has been to give, if not a new point of departure to the science of ethics, at least a completely new conception as to the origin of the faculties with which that science has to deal; and without attempting to discuss the objections which have been raised against the doctrine, or to enumerate the points of contact between this doctrine and older ethical theories—to neither of which undertakings would our present space be adapted—we may say in general, that, as in the case of instinct, so in that of conscience, we feel persuaded that Mr. Darwin's genius has been the first to bring within the grasp of human understanding large classes of phenomena which had been previously wholly unintelligible.

"The Expression of the Emotions in Man and Animals" is an essay which may be more suitably mentioned in the present division than in any of the preceding. The work is a highly interesting

one, not only on account of its philosophical theories, but also as an extensive accumulation of facts. "The three chief principles" enunciated by the former are: (1) "the principle of serviceable associated habits"; (2) "the principle of antithesis"; and (3) "the principle of actions due to the constitution of the Nervous System, independently from the first of the Will, and independently to a certain extent of Habit." It is shown that the first of these principles leads to the performance of actions expressive of emotions, because "certain complex actions are of direct or indirect service under certain states of mind, in order to relieve or gratify certain sensations, desires, &c.; and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not then be of the least use." The second principle arises because, "when a directly opposite state of mind is induced, there is a strong and involuntary tendency to the performance of movements of a directly opposite nature, though these are of no use; and such movements are in some cases highly expressive." And the third

principle occurs because, "when the sensorium is strongly excited, nerve-force is generated in excess, and is transmitted in certain definite directions, depending on the connection of the nerve-cells, and partly on habit." All these principles are more or less well substantiated by large bodies of facts, and although the essay, from the nature of its subject-matter, is necessarily not of so transforming a character in psychology as those which we have already considered, and although we may doubt whether it gives a full explanation of every display of expressive movement, we think there can be no reasonable question that the three principles above quoted are shown to be true principles, and therefore that the essay is completely successful within the scope of its purposes.

Lastly, we have to allude to the brief paper published in *Mind* on the psychogenesis of a child. These notes were not published till long after they were taken, so that Mr. Darwin was the first observer, in a department of psychology which —owing chiefly to the attention which his other writings have directed to the phenomena of evolution—is now being very fully explored. The

observations relate entirely to matters of fact, and display the same qualities of thoughtfulness and accuracy which are so conspicuous in all his other work.

On the whole, then, we must say that Mr. Darwin has left as broad and deep a mark upon Psychology as he has upon Geology, Botany, and Zoology. Groups of facts which previously seemed to be separate, are now seen to be bound together in the most intimate manner; and some of what must be regarded as the first principles of the science, hitherto unsuspected, have been brought to light. No longer is it enough to say that such and such actions are the result of instinct, and so beyond the reach of explanation; for now the very thing to be explained is the character and origin of the instinct —the causes which led to its development, its continuance, its precision and its use. No longer is it enough to consider the instincts manifested by an animal, or a group of animals, as an isolated body of phenomena, devoid of any scientific meaning because standing out of relation to any known causes; for now the whole scientific import of instincts as manifested by one animal depends on

the degree in which they are connected by general principles of causation with the instincts that are manifested by other animals. And not only in respect of instincts, but also in respect of intelligence, the science of comparative psychology may be said for the first time really to have begun with the discovery of the general causes in question; while from the simplest reflex actions, up to the most recondite processes of reason and the most imperious dictates of conscience, we are able to trace a continuity of development. A revelation of truth so extensive as this in the department of science which, in most nearly touching the personality of man, is of most importance for man to explore, cannot fail to justify the anticipations of the revealer, who, in referring to psychology, could "in the future see open fields for far more important researches" than those relating to geology and biology. If the proper study of mankind is man, Mr. Darwin has done more than any other human being to further the most desirable kind of learning, for it is through him that humanity in our generation has first been able to begin its response to the precept of antiquity —*Know thyself.*

The series of brief *résumés* whereby we have endeavoured to take a sort of bird's eye view of Mr. Darwin's great and many labours have now drawn to a close. But we cannot finish this very rudimentary sketch of his work without alluding once more to what was said in the opening paragraphs of the series, and which cannot be more tersely repeated than in Mr. Darwin's own words there quoted with reference to Prof. Henslow: "Reflecting over his character with gratitude and reverence, his moral attributes rise, as they should do in the highest character, in pre-eminence over his intellect."

In the gratitude and reverence which we feel in a measure never to be expressed, we sometimes regret that the ill-health which led to his seclusion prevented the extraordinary beauty of his character from being more generally known by personal intercourse. True it is that the world has shown in a wonderful degree a just appreciation of this character, so that many thousands in many nations who had never even seen the man, heard that Charles Darwin was dead with a shock like that which follows such an announcement in the case of a well-

loved friend; still it seems almost sad that when such an exalted character has lived, it should only have been to so comparatively few of us that the last farewell over the open grave at Westminster implied a severance of feelings which had never been formed before, and which, while ever living among the most hallowed lights of memory, we know too well can never be formed again. But to those of us who have now to mourn so unspeakable a loss, it is some consolation to think, while much that was sweetest and much that was noblest in our lives has ended in that death, his great life and finished work still stand before our view; and in regarding them we may almost bring our hearts to cry—Not for him, but for ourselves, we weep.

G. J. R.

THE END.

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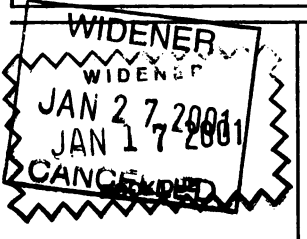

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